THE GOLEMIC APPROACH

by Lee Felsenstein
Golemics, Inc.
1407 Addison St.
Berkeley. CA 94702

pg 1

Abstract

The concept of the "golemic" approach taken to the design of automatic devices is introduced and compared with the current "robotic" approach. Golemic devices incorporate the human user into the feedback loop and interact with the user on a primarily non-verbal basis. They require a higher degree of learning and device sensitivity on the part of the user than the robotic devices which are their equivalent. The paper describes a way of approaching problems in machine intelligence by making use of the intelligence and learning capacity of the user.

The Frankenstein Myth

The area of machine development which is called "robotics" is based upon the premise that machines can be made which perform functions previously the exclusive province of people. This usually involves the concept of the "fully automatic device" which, once set into motion, performs its assigned task without further human intervention.

For any non-trivial task thus automated, something approximating judgment is a necessary component of the robotic device. The development of the mathematics of feedback control systems in the 1940's and 50's led to the real hope that sometime very soon devices would be developed which incorporate this "machine intelligence", and that given further development machine intelligence could be refined to the point where it proved superior to human intelligence in many respects. This would usher in a new golden age in which labor would be reduced to recreation.

Against this hope were raised several warnings -- that if successful the robotic devices would lead to the downfall of humanity in any of several ways. People would either become dependent on the robots in an infantile manner, the robots would exercise a paternalistic control over all people "for their own good", or the robots would revolt against their creators and exert their superior capabilities toward the destruction of humanity. This last image has stuck in the popular mind as the "Frankenstein legend", in which the hulking, unstoppable humanoid filled with a malevolent hatred of the now-inferior humans rampages across the face of the earth destroying all in its path. This legend is so widely accepted and prevalent in industrial society as to warrant some deeper examination.

Isaac Asimov, creator at age 19 of the Laws of Robotics, has said that his non-Frankensteinian concepts came from the application of rational analysis to the problem. He ascribes the Frankenstein legend to the Oedipal fear on the part of the father of being overpowered by his son.

This Freudian approach is not without merit, although it fails to explain the fact that the original Frankenstein story was written by a woman, Mary Wollstonecraft Shelley. Of course, the primary question is not so much about the writer, but about the widespread acceptance of the myth.

In this connection it must be noted that, although the Frankenstein tale was written in 1818, it remained a minor addition to literature until 1930, when a popular film was made based upon it. Boris Karloff's characterization of the monster (it was the creator, not the monster who was named Frankenstein, incidentally) has remained ever since a powerful symbol of the power of technology gone mad.

The diference, aside from the simplification which is a Hollywood trade mark, rests in the society within which the story is told. Shelley's society was in the initial stages of the Industrial Revolution, with the conquering of sheer physical want still a distant utopian image. People still starved in public then, and the humming of the wheels of industry then seemed a revolutionary new hope which might one day vanquish the four horsemen of the apocalypse.

The industrialized society of 1930 was one quite different in the perception of technology and its uses. The wave of prosperity experienced in the 1920's, which seemed to have brought the world to the brink of the abolition of want, had crashed in upon itself in a social maelstrom which saw farmers unable to sell crops and workers unable to buy food. Technologically based society, then, was what the monster of Frankenstein represented. It has proven to be a durable image, unfortunately.

Golem To The Rescue

The blessings of industrialization have brought with them new problems such as the prospect of extinction through war or pollution, of the death of culture at the hands of the mass media, or the paradoxical reduction in choice as the scale of production grows (can anyone tell the difference among the various brands of Americal cars these days?). These, along with the prospect of meaningless leisure time, are very real problems, sensed as such by most people within industrial society, and promises of ultimate wind-up toys to make and carry out all our decisions for us do not address them.

Please remember that this is being written by an engineer. The foregoiong is simply by way of introduction. I am not about to walk away at this point shaking my head and muttering about how things were so much better in the old days.

One of the secrets of engineering is that tasks previously thought impossible can be accomplished if they are redefined (i.e. -- when it won't work, change the specs). With an eye toward redefinition, let's take a look back to one of the primary sources of the Frankenstein story.

That is the legend of the Golem, which arose in the Jewish ghettoes of eastern Europe in the middle ages. The Golem was a human figure of clay fashioned by the rabbi of the community and animated by the technology of the Kabbalah, a mystical branch of Judaism. The crucial element in the animation was a shem, or name, written on the forehead of the figure or on a piece of parchment inserted in the mouth of the figure. Usually this was the unspeakable name of God, although it varies among various legends. The creation of the Golem was occasoned by divine revelation in response to prayers for a protector against the attacks of the anti-semites.

The largest collected body of Golem tales revolves around

Rabbi Low of Prague, an historical character who lived around 1580. One of the tales (1) provided the source for Goethe's Sorcerer s Apprentice and other tales. In this story the Golem, which had been reserved for work as a sexton in the synagogue, is ordered by the rabbi's wife to fill the kitchen water kegs from the spring. A flood ensues, and the Golem is discovered to be dumping water into overflowing kegs. The rabbi, in effect, inserts a "halt" command into the Golem's program, and the episode ends among much laughter.

pg. #3

Here is a mythical charater much more like the machines we know from our world of kluges, patches and crashes. The automatic beast is capable. but only in a limited way, and needs constant attention to avoid a bumbling disaster. There's nothing malevolent motivating it, but we mustn't assume because of that that it is benevolent. It's just an amplified bdundle of our own inevitable shortcomings, and design which overcomes some of them will most likely emphasize others.

This way of viewing automatic devices I call the golemic outlook. as contrasted to the robotic outlook, which holds that machines can achieve a level of perfection greater than man.

They Said It Couldn't Be Done

Applying a golemic outlook to the problems of automatic device control we are lead to the desire to keep a closer eye on the device than the robotic outlook would imply. Before we go further some background is needed in automatic control terminology.

Figure 1 shows the basic block diagram of the generalized feedback device. The output is the desired performance of the system. This performance is made possible by a prime mover operating under command of a control input. This may be an engine where the control is the throttle lever. The setting of the control is determined by a comparison between the actual. measured performance and the ideal performance as set by the input, which in this analogy might be the setting of a speed control. The performance is measured by some device which samples the output. In our engine analogy this might be a centrifugal governor which converts the speed of the shaft rotation into a lever position.

The term used for the prime mover and its comparison device is the "feedforward loop", and the term for the sampling device is the "feedback loop". The input is the point at which orders are given to the system and the logic of how the system carries out orders is determined by the design of both the feedforward and the feedback loops.

In the robotic conception humans are given operational control of the system through the input only. New feedback loops can be designed. and new prime movers specified. but this is a painstaking process reserved for experts only.

The golemic outlook demands that the operator have operational control over the feedback loop. The device must always allow the operator to override the logic of the loop and must keep the operator aware of the decisions which the machine is making. The device amplifies the user s capabiltiies through the feedforward loop. and amplifies the user s senses through the feedback loop. providing information such as limited time projections of outcomes given no changes in control information. plan views of the device in its sensed environment. and proportional resistance to tactile control efforts. To work effectively within such a feedback loop will require of the operator some specialized training of the senses and some adaptation of judgmental

abilities, but people can do this kind of learning much more reliably and efficiently than most machines.

Do you scoff? Look again! The ubiquitous automobile is just such a golemic device. Remember the first time you steered a car while learning to drive? You probably needed a lot of clear space. But quickly you developed what the Highway Patrol calls "vehicle sensitivity" -- a "feel" for the way the car behaved as you controlled it. Quickly you learned to serve as an effective feedback loop for the mechanism -- it certainly had none of its own in so far as movement was concerned. A machine that can adapt as quickly and effectively as that has not yet been built. The car, for its part must incorporate a "road feel" in the steering and suspension so as to allow the driver to get sufficient information to exercise control reliably.

pg. #4

This has been going on under the very noses of the artificial intelligence laboratories, while General Motors is no longer making noises about the great future in which cars will drive themselves.

The Digital Golem

All forms of automatic control face a proliferation now that computers are small and cheap enough to become low-cost components. It is my contention that robotics will make little progress until designers take more of a gdolemic viewpoint in approaching the design of automatic systems.

In systems incorporating a computer as a feedback element this means in great part the presentation of feedback data in non-verbal form such as visual, audible, tactile, even thermal. Likewise, any action on the part of the operator should not have to go through a process of conversion to verbal information. We should not be afraid to create new "spaces" of information within which the operator can be expected to learn to function (an example would be a view screen which shows an overlap of magnetic, infrared, and visible views of the same scene, with differentiation by color, accompanied by a tone whose frequency and amplitude represent some status of the system).

We should be prepared to design situations in which the prospective user can learn the "device sensitivity" at the highest level of interaction which the learning process can sustain. This means that the learning process should be built into the design of the equipment. I have personally followed this principle in designing personal computer equipment with some success. I call the quality of the design which includes the user in the learning process the "conviviality" of the design, a term and concept taken from Ivan Illich's "Tools For Conviviality" (2), which all should read

Given the application of the golemic outlook, we can look forward, I believe, to a society in which rather than bringing about the displacement of people from useful and rewarding work, machines will effect a blurring of the distinction between work and play. In such a society, for instance, the collectors of trash would go about their rounds without having to wallow in filth, since they would be accompanied by "garbage golems" which would heft the trash cans and dump them into collection bins under interactive control by the collector, who would in turn have a "feel" for the weight, balance, and flexibility of the can being handled. Recalcitrant cans could be shaken, tapped, or even scraped out by the golem, always under the operator's control.

Clerks would be engaged in an operation more like the playing of a multi-machine video game, seated before video screens on which they seem to scoot among fantastic shapes and colors representing the bodies of data which they probe. Files would come up looking very much like printed paper, but they would be of indeterminate length, and devoid of hazards like hangnails and paper cuts. Misfiled items would stand out as an irregularity of color or form. The clerk could take action or simply take the anomaly as a new feature of the information space to be noted and worked around

Drudgery would have no place in this world, having been handed to the machines as their lot. But the decisionmaking, where the rewarding part of even the most common task lies, that would be left for the people who uses and benefit from the design of the tools

Power's More Than E Times I

A necessary byproduct of such convivial and golemic tools is that those who use them would in time gain a deep familiarity with them. We could expect a feedback mechanism to develop through which ideas for the improvement of the design would come from people who used the equipment instead of from remote experts. The stark vision of a society dominated by a technocratic elite of designers and administrators need not materialize, even though we are halfway there. This will, of course, not happen automatically.

The main appeal of personal computing, so I believe, is to people who want to invert the technocratic tendency of society and to gain for themselves the power to control the tools which they must use. The development of a golemic outlook toward the design of automatic devices will, I hope, prove to be valuable in continuing this process of empowerment of the individual.

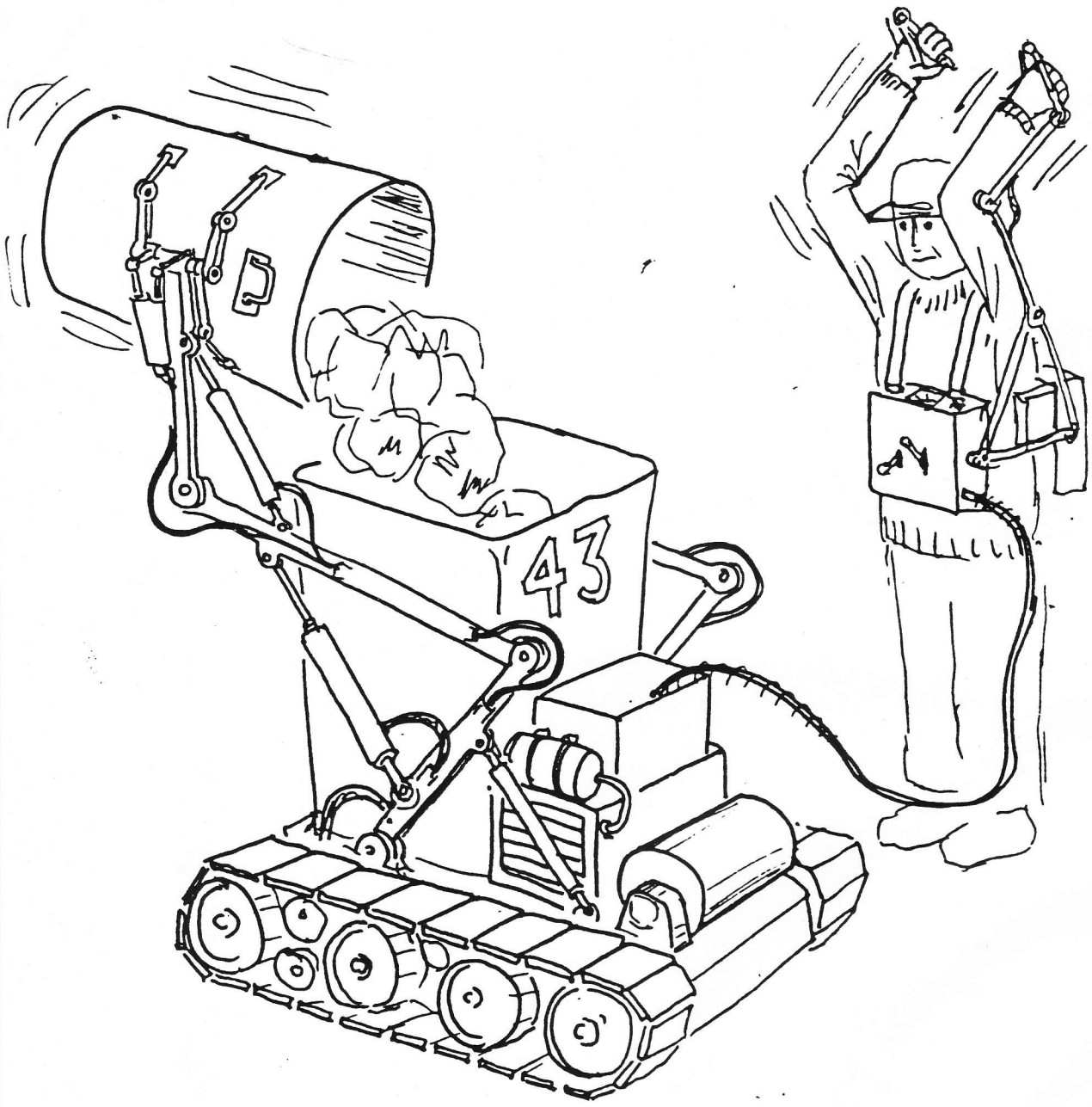
Acknowledgment

This paper constitutes a lifting of Ted Nelson's ideas regarding the higher virtuality from the area of text handling and their placement into the area of feedback control. Ted has borne true faith in proselytizing his ideas, and it has worked in my case.

References

(1) The Golem - Mystical Tales From The Ghetto of Prague

(2) Tools For Conviviality, by Ivan Illich. Harper and Row, New York, 1971


143